

**A new genus and species of South American fishes
(Teleostei: Characidae: Cheirodontinae) with a derived caudal fin,
including comments about inseminating cheirodontines**

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Abstract.—*Acinocheirodon melanogramma* from tributaries of the rio São Francisco and the rio Jequitinhonha, Minas Gerais, Brazil, is described as a new genus and species of inseminating cheirodontines. The adult males are distinguished by possession of modified thirteenth to fifteenth, ventral caudal-fin rays bearing dorsally directed hooks surrounded by fleshy, possibly glandular, structures. These structures appear similar to, but are here hypothesized as convergent with some of the derived caudal glandular organs of certain glandulocaudine characids and the species of the incertae sedis characid genus *Brittanichthys*. Putative relationships of these taxa to the new genus are explored and rejected. The new species is referred to the Cheirodontinae on the basis of a cladistic diagnosis of this subfamily. Hypotheses of relationships with other inseminating cheirodontines bearing modified caudal fins are explored.

Resumo.—*Acinocheirodon melanogramma*, dos afluentes do rio São Francisco e rio Jequitinhonha, Minas Gerais, Brasil, é descrito como um novo gênero e nova espécie de Cheirodontinae com inseminação. Os machos adultos são caracterizados por possuírem o décimo terceiro ao décimo quinto raios da nadadeira caudal modificados, curvados ventralmente, portando ganchos e tecidos hipertrofiados semelhantes, mas consideradas convergentes com os órgãos caudais glandulares de certos Glandulocaudinae e de *Brittanichthys*, um gênero incertae sedis em Characidae. Relações hipotéticas entre estes táxons e o novo gênero são exploradas e rejeitadas. A nova espécie é referida a Cheirodontinae com base em uma nova diagnose cladística da subfamília. São discutidas as hipóteses de relações com outros Cheirodontinae inseminados e portando nadadeiras caudais modificadas.

While searching for cheirodontine characids in the collections of the Museu Nacional de Rio de Janeiro, one of us (LRM) found seven specimens of an undescribed small characid species from the rio Jequitaí, rio São Francisco drainage, Minas Gerais, Brazil. Another specimen from the middle portion of the rio Jequitinhonha, Minas

Gerais, Brazil was found (by SHW) in the Museu de Zoologia da Universidade de São Paulo while searching for glandulocaudine characids. The rio Jequitinhonha is independent of the rio São Francisco basin, but is an adjacent coastal plain river of eastern Brazil. Subsequent joint collections of Museu de Ciências e Tecnologia, Pontifícia

Universidade Católica do Rio Grande do Sul, Porto Alegre, the Academy of Natural Sciences, Philadelphia, and the Universidade Federal de São Carlos, São Paulo resulted in additional specimens from both rivers.

Some of the caudal-fin structures of this species appear convergent with those of certain of the glandulo-caudine characids, especially those of the tribe Corynopomini of eastern Brazil and the rio Paraguay basin. Also, males in the new genus bear decurved caudal-fin rays in the ventral caudal-fin lobe, suggesting some of the caudal-fin modifications present in the glandulo-caudine tribe Glandulo-caudini. Our collaboration regarding the description of the new species grew out of our respective and joint interests in the cheirodontine and glandulo-caudine characids and the primary and secondary sexual features found in both groups such as their gonad modifications associated with insemination and their caudal-fin modifications associated with courtship.

The new species has hooks on some of the caudal-fin rays and hypertrophied caudal-skin tissue surrounding the hooks that may be glandular. The caudal-fin hooks in males of the new genus (Figs. 3–6) are derived compared to other inseminating cheirodontines that have caudal-fin hooks in that not only are they directed dorsoanteriorly, but the hooks are longer and more slender and are borne by thickened ray segments. Compare these hooks with those shown for "*Odontostilbe*" *mitoptera* (Fink & Weitzman, 1974:fig. 3). Note that Malabarba et al. in Malabarba (1998) included "*O.*" *mitoptera* in their new tribe Compsurini, but so far the genera of this group have not been fully analyzed cladistically and a meaningful generic assignment for this species is not available. We therefore use the most recent generic allocation from Malabarba (1998). Because the new genus and species is included in the cheirodontine tribe Compsurini by several synapomorphies at several nodes and is therefore ex-

cluded from the Glandulo-caudinae as well as other characid groups bearing caudal-fin hooks, its caudal hooks may be considered derived independently from those excluded taxa. The posteriorly placed caudal-fin hooks of the new genus and species might suggest a relationship to the species in the characid genus *Brittanichthys* Géry, 1965b: 13, but this is rejected in more detail below.

Four synapomorphies were provided by Malabarba (1994, 1998), also briefly discussed by Weitzman & Malabarba (1999), to diagnose a monophyletic Cheirodontinae in a more restricted and rigorous sense than that defined by Eigenmann (1915) and discussed by Géry (1977). The new genus and species shares all four of these synapomorphies and we do not consider it to be closely related to the glandulo-caudines, or to *Brittanichthys*.

After initiating our study of this new species, it was discovered that those cheirodontine characids bearing modified hypertrophied caudal tissue and/or hooks on some of the caudal-fin rays are inseminating (Burns et al. 1997) as are all glandulo-caudines (Burns et al. 1995), and *Brittanichthys* (see Weitzman et al. 1994, Weitzman & Menezes 1998). However, Burns et al. (1998) found that the testis morphology and the fine structure of the sperm cell nuclei of the glandulo-caudines are uniquely derived. Inseminating cheirodontines also have derived sperm nuclei, but these are differently modified from those of the glandulo-caudines as well as those of certain other inseminating characids (Burns et al. 1998). This suggests a hypothesis of independent acquisition of insemination of cheirodontines and glandulo-caudines, but the two subfamilies could be sister taxa, simply having their sperm cell bodies derived in different directions from an inseminating common ancestor. However, Malabarba (1988) offered evidence that the Compsurini which includes the new genus, is a sister group to a taxon derived from within the non-inseminating cheirodontine groups and therefore the tribe is not a sister taxon to

the Glandulocaudinae or other inseminating characid groups. The possible relationships of the new genus to other inseminating cheirodontines are briefly explored below.

Methods

Our comments on the phylogeny of the Cheirodontinae and other characids are based on the concepts of phylogenetic systematics as reviewed and discussed by Wiley (1981). The term diagnostic character is used to designate one or a series of synapomorphies or autapomorphies that are characteristic of a particular taxon. The term distinguishing character is used for one or a series of characters that help to distinguish one taxon from others, but no phylogenetic information is implied; see also Weitzman et al. (1994:48). Distinguishing characters may or may not be apomorphic. No phylogenetic information is implied because the potential comparative derived nature of distinguishing characters are not analyzed. The two terms, diagnostic character(s) and distinguishing character(s), are so defined in order to differentiate phylogenetic (cladistic) treatments from those bearing no phylogenetic information.

Counts and measurements are the same as those described by Fink & Weitzman (1974:1–2) and Menezes & Weitzman (1990:382–383). For counts recorded in the descriptions of the new species, the holotype is listed separately and first. This is followed in parentheses by the range, mean (\bar{X}) and total number of specimens having that count. When the condition of the specimens were such that certain characters could be taken from only a few specimens and reasonable descriptive statistics were impossible, only the extremes and a statement of the modal count are given, but there will be no mode when all counts are the same. In the Table nearly all measurements other than standard length (SL) are expressed as a percentage of SL, except subunits of the head that are recorded as a percentage of the head length (HL). Verte-

bral counts include the Weberian apparatus. The terminal half centrum, hypural bones and associated vertebral elements, together usually designated as $PU_1 + U_1$, but not necessarily consisting only of those vertebral elements, were counted as one vertebra. Vertebral counts and usually fin-ray counts were taken from radiographs and from C&S (cleared and stained) preparations prepared according to Taylor & van Dyke (1985).

As in Menezes & Weitzman (1990:383), geographic entities (such as rivers) and place names (except those of countries) are in the language of the country of origin. Countries are in English because English names are available for these. The word rio (rio in Portuguese, río in Spanish) is not capitalized when referring to a river (thus, for example, río Baria in Venezuela and rio Itá in Brazil). However, rio would be capitalized when referring a place name such as a town or city. We do this in an attempt to avoid the transferal of English style and grammar onto foreign place names and geographical entities. Coordinates are used whenever possible, but are used only when we have confidence in their approximate accuracy.

The following acronyms are used for institutions and collections: FMNH, Field Museum of Natural History, Chicago; MCP, Museu de Ciências e Tecnologia, Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre; MNRJ, Museu Nacional do Rio de Janeiro, Rio de Janeiro; MZUSP, Museu de Zoologia da Universidade de São Paulo, São Paulo; UFSCar, Universidade Federal de São Carlos, São Carlos; USNM, former United States National Museum, now the National Museum of Natural History, Smithsonian Institution, Washington D.C.

In addition to HL and SL the following abbreviations are used in the text or figures: C&S = alizarin red s and alcian blue stained specimens cleared with trypsin; spm(s) = specimen(s).

Acinocheiroduon, new genus

Type species.—*Acinocheiroduon melano-gramma*, new species.

Diagnosis.—The penultimate and antepenultimate ventral procurrent caudal-fin rays of males have their tips ventrally expanded, forming a small keel in the ventral profile of the caudal fin (Figs. 1, 3–4). The cheirodontines *Serrapinnus piaba* (Lütken, 1874), *S. calliura* (Boulenger, 1900), *S. kriegi* (Schindler, 1937), and *S. notomelas* (Eigenmann, 1915) also bear three ventrally expanded posteriormost ventral procurrent caudal-fin rays, forming a small keel in the ventral profile of the caudal fin. Although the same procurrent rays are involved in the keels of those cheirodontine species referred to *Serrapinnus* Malabarba (1998), and *Acinocheiroduon*, these differ in shape and involve different portions of the fin rays in the two genera. The four *Serrapinnus* species have an expansion along the posterior half of the ray rather than at the tip of the last three ventral procurrent caudal-fin rays and are more closely related to *Cheirodon* Girard (1855) with which they share several synapomorphies involving the anteriormost ventral procurrent caudal-fin rays, and specifically to *Spintherobolus* Eigenmann (1911) by sharing several synapomorphies associated with the anal fin of males, (Malabarba 1998, Weitzman & Malabarba, 1999).

The thirteenth, through the fifteenth principal caudal-fin rays of males are ventrally bowed, leaving wider spaces between principal caudal-fin rays twelve to fifteen than found between the other caudal-fin rays of this species (Figs. 1, 3–6).

The thirteenth and fourteenth principal caudal-fin rays of fully mature males bear thickened ventrally expanded segments.

The fourteenth principal caudal-fin ray of males has a dorsally extending flap along the proximal two thirds of its length. This does not overlap the thirteenth principal caudal-fin ray. The tissue between the fourteenth and fifteenth principal caudal-fin rays

of males has a large dorsally extending flap that overlaps the fourteenth ray along almost its entire length. There is a ventral smaller skin flap along the posterior half of this structure that does not overlap the fifteenth principal caudal-fin ray ventrally (Figs. 3, 6). Hypertrophied soft tissue surrounds the caudal-fin ray hooks and extends anteriorly in diminishing amounts along fin rays thirteen to fourteen to their bases (Figs. 3, 6). This tissue may be glandular, but this needs histological confirmation.

The presence of anal-fin hooks positioned along the posterolateral border of the anal-fin rays and directed to the anal-fin base; the anal fin not pigmented along its distal margin; the five cusped dentary teeth, with three central cusps larger and nearly equal in size (Fig. 7B); and the complete lateral line; were all found ambiguous regarding relationships, but also distinguished *Acinocheiroduon* from the other members of the Compsurini in a global parsimony analysis (Malabarba 1998).

Etymology.—The first component of the name *Acinocheiroduon* is from the Greek, *akaina* = thorn or spike and refers to the spines on the caudal-fin rays. The remainder of the word refers to the characid genus *Cheirodon* in reference to our referral of the new genus to the Cheirodontinae.

Acinocheiroduon melanogramma,

new species

Figs. 1–7

Note: This species and genus equals “undescribed genus and species B” in Burns et al. (1997) and “new genus and species B” in Malabarba (1998).

Type specimens.—Brazil, Minas Gerais, rio São Francisco drainage.

Holotype—MNRJ 16455, male, 31.8 mm SL, município de Bocaiúva, córrego Cachoeira, tributary to rio Jequitaiá, km 413 of highway BR 135, approximately 17°28'S, 44°02'W (Reference map: WAC—Carta Aeronáutica Mundial 3190, Goiânia, 1976), 24–30 Sep 1990, D. F. Moraes Jr.



Fig. 1. *Acinocheirodon melanogramma*, new species, holotype, MNRJ 16455, male, 31.8 mm SL; Brazil, Minas Gerais, município Bocaiúva, córrego Cachoeira, tributary to rio Jequitai, rio São Francisco basin, 24–30 September 1990.

Paratypes—MNRJ 13435, 4 spms., 2 males, 27.4–28.0 mm SL, 1 female, 27.4 mm SL, 1 male C&S, 28.6 mm SL; MCP 18596, 1 male, 27.6 mm SL (listed as un-

described genus and species B in Burns et al. 1997); MCP 18598, 1 female, 26.3 mm SL (listed as undescribed genus and species B in Burns et al. 1997), all collected with



Fig. 2. *Acinocheirodon melanogramma*, new species, paratype, MNRJ 13435, female, 27.4 mm SL; Same locality data as in Fig. 1.

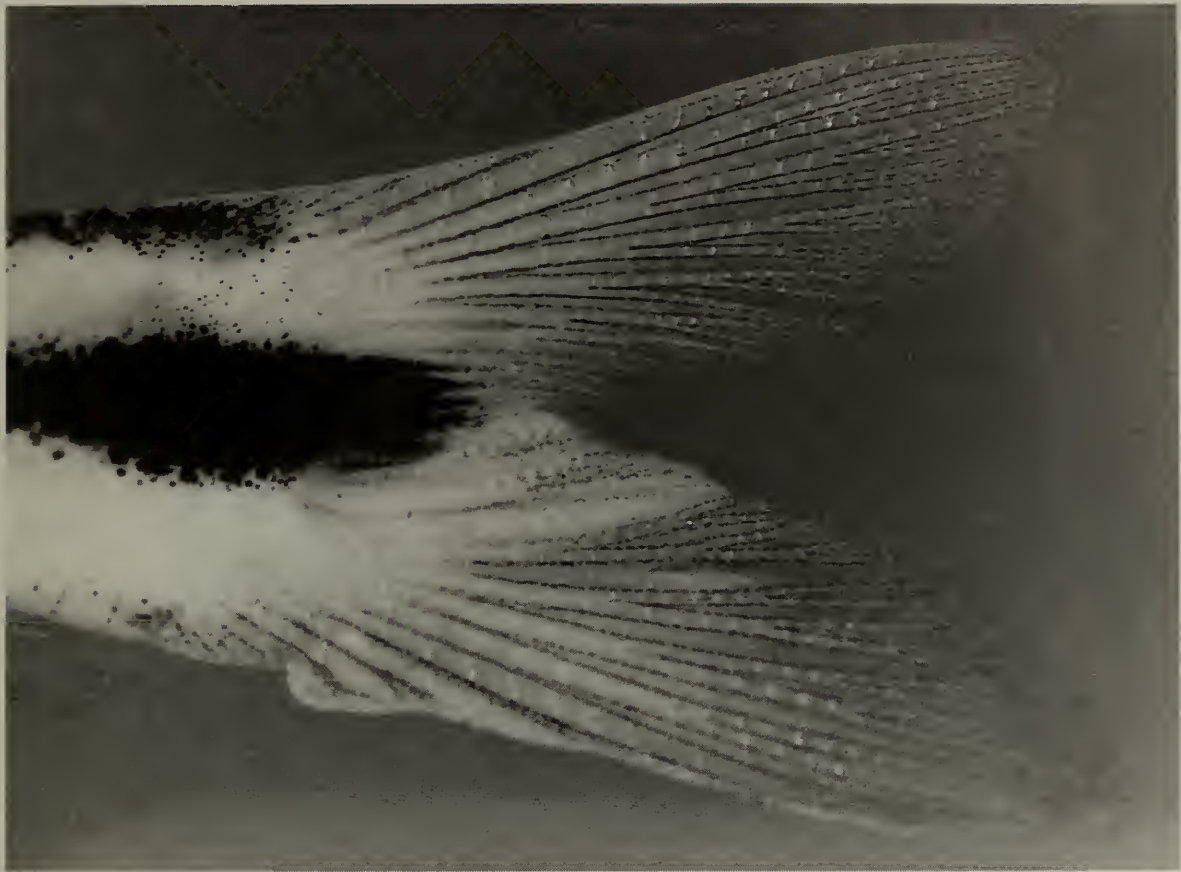


Fig. 3. *Acinocheirodon melanogramma*, new species, paratype, MNRJ 13435, male, 28.0 mm SL; same locality data as in Fig. 1. Caudal peduncle and fin (lateral view, left side, rays 13 and 14 bear fin hooks).

the holotype. MCP 16472, 6 spms, 2 males, 27.0–28.1 mm SL, 4 females, 26.2–30.0 mm SL; ANSP 176238, 7 spms, 3 males, 24.5–26.2 mm SL, 4 females, 21.9–25.6 mm SL, both lots collected from highway BR 153, S of Montes Claros, município de Bocaiúva, approximately 17°65'31"S, 43°49'48"W, 20 Jul 1993, R. E. Reis, S. A. Schaefer, J. P. Silva, & E. L. Pereira.

Non-type specimens from rio Jequitinhonha drainage:—MCP 19142, 16 spms, 9 males, 31.6–34.4 mm SL, 7 females, 29.1–37.3 mm SL; ANSP 173799, 16 spms, 14 males, 31.4–36.5 mm SL, 2 females, 29.6–31.4 mm SL, both lots from rio Jequitinhonha at São Pedro do Jequitinhonha, Itaobim, approximately 16°30'35"S, 41°20'02"W, 20 Jan 1995, R. E. Reis, W. G. Saul, S. Schaefer, & J. F. P. da Silva. MZUSP 5132, 1 spm., C&S, male, 34.4 mm SL, município de Medina, rio Jequitinhonha at Itaobim, approximately 16°33'S, 041°30'W (Reference map: WAC—Carta

Aeronáutica Mundial 3189, Belo Horizonte, 1976), 25 Jun 1966, H. Britski and N. Menezes. USNM 318486, 59 spms, 4 young males, 23.3–29.7 mm SL, 55 juveniles and females, 17.3–24.9 mm SL, tributary of rio Jequitinhonha known as rio ribeirão, approximately 4–5 km ESE of município de Jordânic, about 15°54'S, 40°10'W, 12 Jul 1991, R. M. C. Castro & S. Jewett. MCP 18597, 2 spms, females, 30.5–37.7 mm SL (listed as undescribed genus and species B in Burns et al. 1997); MCP 19238, 8 spms, 4 males, 28.4–32.2 mm SL, 1 male, C&S, 33.3 mm SL, 3 females, 26.4–35.1 mm SL; MZUSP 52434, 8 spms, 4 males, 28.3–35.7 mm SL, 4 females, 29.9–30.6 mm SL, all three lots from rio Jequitinhonha below mouth of rio Araçuai, município de Itira, 10 Jan 1989, J. C. Garavello, A. S. Soares, A. I. Alves, & J. C. Soares.

Diagnosis.—The same as for the genus. All unambiguous characters listed in the diagnosis above are secondary sexual features

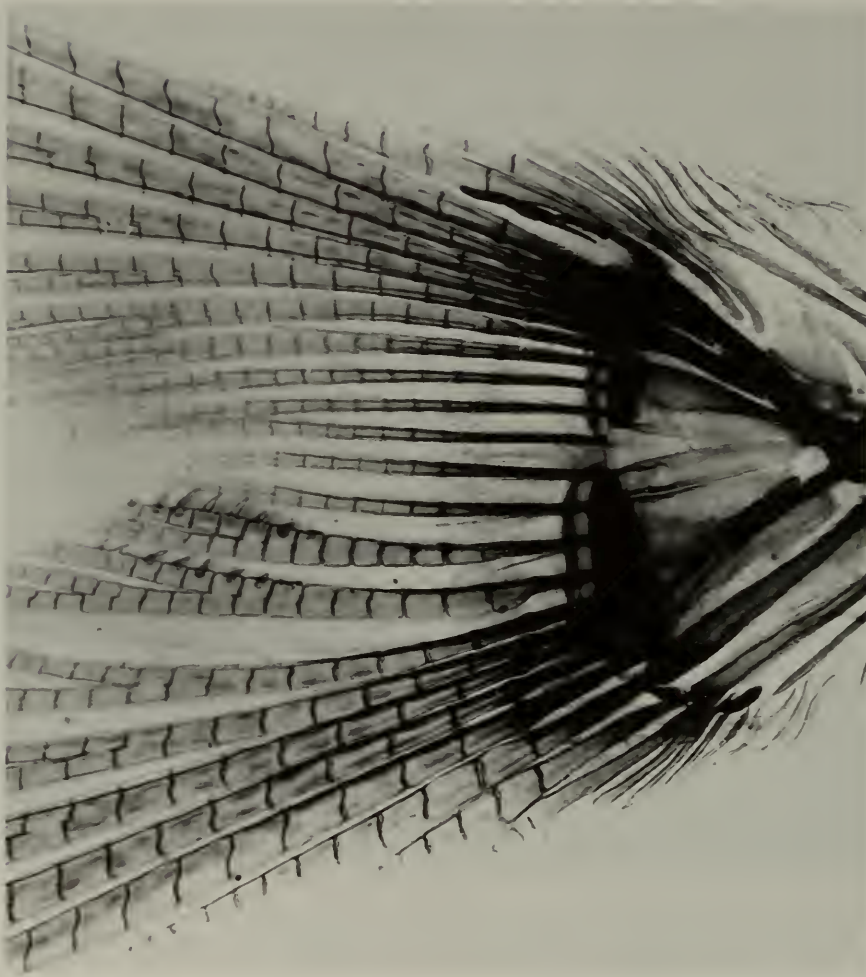


Fig. 4. *Acinocheirodon melanogramma*, new species, paratype, MNRJ 13435, cleared and stained male, 28.6 mm SL; same locality data as in Fig. 1. Caudal fin base, procurrent caudal-fin rays and hook-bearing portion of caudal fin.

that allow only the identification of males of *A. melanogramma* among cheirodontines.

Distinguishing characters.—The following distinguishing characters allow the recognition of both male and female specimens: A small, but distinctive black band occurs along the distal tip of the first unbranched dorsal-fin ray (Figs. 1–2) and distinguishes *A. melanogramma* from other cheirodontines, except *Macropsobrycon uruguayanae* Eigenmann (1915) and *Compsura heterura* Eigenmann (1915). The absence of modified caudal-fin scales and the presence of multicuspid instead of conical teeth, respectively distinguish *A. melanogramma* from *C. heterura* and *M. uruguayanae*.

Description.—Morphometrics given in Table 1. Body moderately elongate and

compressed, greatest depth at dorsal-fin origin or somewhat anterior to this position if intestinal canal full of food or female gravid. Predorsal profile convex to snout tip. Profile of body from base of posterior dorsal-fin ray to adipose-fin origin straight or slightly convex, slightly concave posterior to adipose-fin origin. Ventral profile of body convex from tip of lower jaw to pelvic-fin origin and moderately concave to straight from there to anal-fin origin. Profile along male's anal-fin base somewhat convex in anterior half and slightly concave posteriorly. In female entire anal-fin base relatively straight. Dorsal and ventral profiles of caudal peduncle somewhat concave in both sexes. Caudal peduncle slightly longer than deep. Head small, snout short and rounded. Mouth terminal, maxilla short and positioned at an angle of approximately 45

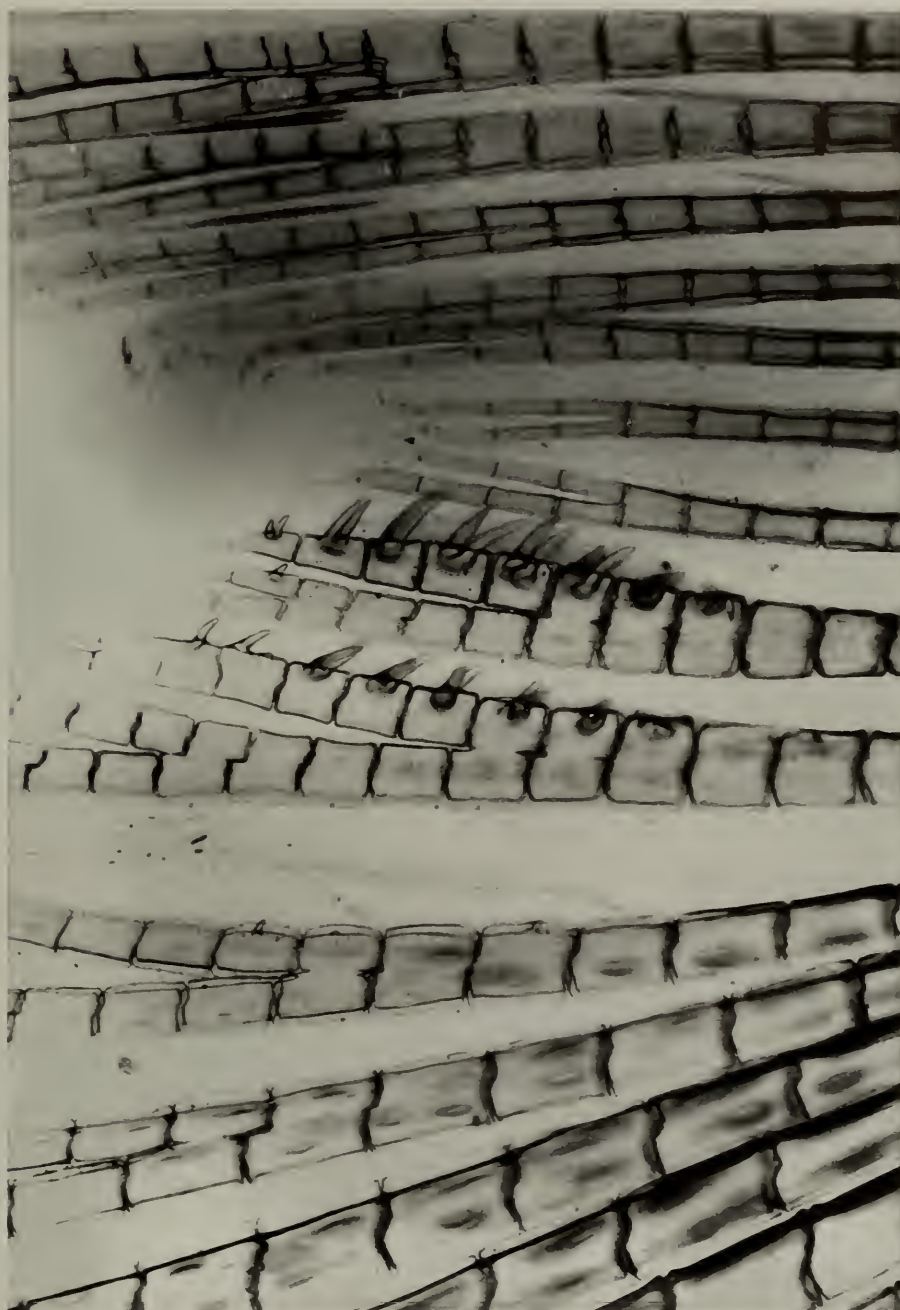


Fig. 5. *Acinocheirodon melanogramma*, new species, paratype, MNRJ 13435, cleared and stained male, 28.6 mm SL; same locality data as in Fig. 1. Caudal-fin portion bearing hooks, right side, anterior is to right.

degrees relative to long axis of body. Posterior end of maxilla reaching a vertical passing through anterior border of iris.

Premaxilla (see Fig. 7A) with 6–7 large more or less symmetrical teeth bearing 3–5 cusps. Center cusp largest, producing an arched tooth profile. Three main cusps are always large. When more than three cusps present, lateral cusps very small. Small cusps usually absent on most medial tooth and on fifth or sixth large tooth posteriorly. Teeth of premaxilla somewhat compressed with teeth and all cusps in a single row.

Premaxillary teeth not compressed as much as those of dentaries or maxillae. Maxilla with 2, rarely 1 or 3 teeth, each usually bearing 5 cusps. Lateral cusps, when present, always smaller than central ones. Maxillary teeth compressed, bearing 3 major more or less flattened conical cusps of approximately equal size; these form a single row on tooth's cutting edge. Dentary teeth 7–9 in a single row, each tooth with 5 cusps. Each tooth with 3 large central cusps: each of these compressed, in a single row and forming sharp cutting edge. One

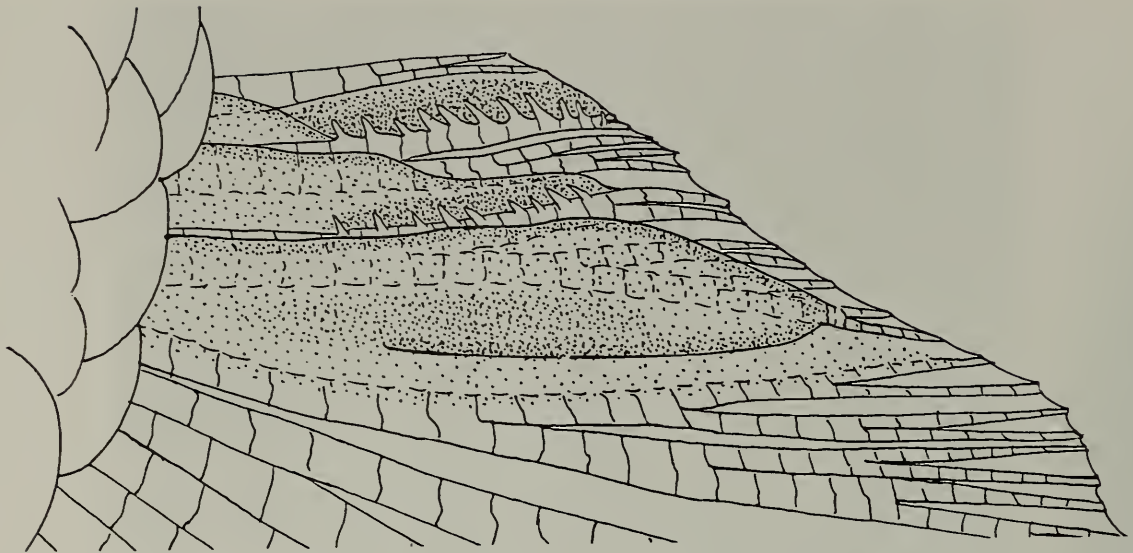


Fig. 6. *Acinocheirodon* cf. *melanogramma*, new species, MCP 19142, male, 34.2 mm SL, Brazil, Minas Gerais, Itaobim, rio Jequitinhonha at São Pedro do Jequitinhonha, 20 January 1995. Caudal-fin rays twelve (up) through fifteen (below), other lower caudal-fin rays partially drawn. Figure shows the distribution of the hypertrophied soft tissue (also present in some specimens from the rio São Francisco) surrounding the hooks and extended anteriorly in diminishing amounts along fin rays thirteen to fourteen to their bases (darkened areas); the large dorsally directed slightly recurved hooks dorsal to the thirteenth and fourteenth principal caudal-fin ray; and the large dorsally extending flap from the fourteenth and fifteenth principal caudal-fin rays of males.

very small cusp at base of larger lateral cusps on each side of each tooth. Median tooth largest and next 3–4 teeth gradually diminish in size, fifth or sixth tooth abruptly smaller and with only 3 cusps. Next posterior teeth much smaller, bearing 2 cusps and last tooth small, unicuspid and conical.

Dorsal-fin rays ii, 9 in all specimens ($n = 19$). First unbranched ray about half length of second. Dorsal-fin origin approximately at midlength of body. Adipose-fin origin a little anterior to posterior anal-fin insertion.

Anal-fin rays iv, 19 (iii–v, 16–19, $\bar{X} = 17.7$, $n = 19$; mostly 17–18; 1 specimen 16, and 3 specimen 19). Female anal fin with anterior 6–7 branched rays very long, forming prominent anterior lobe. Rays posterior to anterior lobe abruptly short. Distal border of anal fin concave and then straight posterior to anterior lobe. Distal border of male anal fin decreasing in length more gradually than in females so that lobe not as sharply distinct from remainder of fin as in females, but anterior anal-fin lobe of adult males proportionally longer than in females or juveniles. Anal-fin rays of males with small,

elongate, retrorse hooks present on longest unbranched ray, and on first 7–13 (usually 8–10) branched rays. Hooks present only on posterior branches of rays and on distal parts of main ray, never on its proximal portion. One pair of bony hooks per ray segment, two pairs rarely occur on first branched ray and posterior unbranched ray-bearing hooks.

Pectoral-fin rays i, 10 (i, 10–12, = 10.8, $n = 20$). Distal ends of longest rays not extending to pelvic-fin origin. Pelvic-fin rays i, 7 ($n = 20$). Pelvic-fin origin anterior to a vertical passing through dorsal-fin origin. In females longest ray does not reach anal-fin origin; in males longest ray reaches just to anal-fin origin. Pelvic fins with unilateral, ventromedian antrorse bony hooks; unbranched and branched rays bearing 1, 2, or rarely 3 slender hooks per segment along most of their lengths. Number of segments bearing hooks varies among males, those males bearing more hooks appearing more mature.

Principal caudal-fin rays 10/9. Dorsal procurrent caudal-fin rays 13 (7–13, $\bar{X} = 10.1$, $n = 20$; 7 in one specimen). Ventral



Fig. 7. *Acinocheirodon melanogramma*, new species, paratype, MNRJ 13435, cleared and stained male, 28.6 mm SL; same locality data as in Fig. 1. Jaws and teeth of right side. Anterior is to right. Top = maxilla and premaxilla. Bottom = mandible. Note: replacement teeth visible because bone is translucent.

procurrent caudal-fin rays 11 (7–11, \bar{X} = 8.8, n = 20). Distal tip of penultimate and antepenultimate ventral procurrent caudal-fin rays of males ventrally expanded and

forming small ventral keel seen in ventral profile of caudal fin; Figs. 1, 3–4. Other ventral procurrent caudal-fin rays not modified. Males with modified 13th through

Table 1.—Morphometrics of *Acinocheirodon melanogramma*, new species from the rio São Francisco basin and *Acinocheirodon cf. melanogramma* from the rio Jequitinhonha basin. Standard length is expressed in mm; measurements through head length are percentages of standard length; the last four entries are percentages of head length. All specimens are from Brazil, Minas Gerais. Described ranges for type specimens (rio São Francisco basin) include measurements of the holotype MNRJ 16455, male, and following paratypes: MCP 18596, 1 male, MCP 18598, 1 female, MNRJ 13435, 2 males and 1 female (measurements of one C&S specimen not taken), MCP 16472, 2 males and 4 females, ANSP 176238, 2 males and 3 females (two specimens not measured). Other specimens (not types—rio Jequitinhonha): ANSP 173799, 4 males and 1 female (11 specimens not measured), USNM 318486, 4 males (55 specimens not measured), MCP 19142, 4 males and 5 females (7 specimens not measured), MCP 19238, 3 males (5 specimens not measured), MZUSP 52434, 1 male (7 specimens not measured).

Character	holo- type	TYPE specimens—rio São Francisco basin						NOT TYPES—rio Jequitinhonha basin					
		males			females			males			females		
		<i>n</i>	low-high	\bar{X}	<i>n</i>	low-high	\bar{X}	<i>n</i>	low-high	\bar{X}	<i>n</i>	low-high	\bar{X}
Standard length (mm)	31.8	8	24.3-31.8	27.4	9	24.0-29.3	26.5	12	30.9-35.7	32.7	6	29.1-33.9	32.1
Snout to anal-fin origin	61.6	8	59.1-65.3	61.9	9	60.5-64.6	63.1	12	60.2-64.4	62.1	6	61.2-64.9	63.2
Snout to dorsal-fin origin	51.3	8	47.5-52.2	50.3	9	48.3-53.7	51.2	12	49.5-51.5	50.4	6	49.7-52.8	50.9
Snout to pelvic-fin origin	45.0	8	44.5-49.6	46.3	9	45.9-47.9	46.9	12	42.6-47.7	45.4	6	42.6-48.1	45.5
Dorsal-fin base length	12.3	8	11.7-13.7	12.9	9	12.4-14.2	13.0	12	10.9-14.1	12.9	6	12.2-13.3	12.9
Anal-fin base length	26.4	8	24.7-27.9	26.2	8	23.2-26.2	24.5	12	24.6-30.0	27.4	6	24.4-26.9	25.9
Caudal peduncle length	14.8	8	13.0-14.8	13.8	8	12.0-15.7	13.8	12	10.5-13.7	12.1	6	10.8-13.2	12.2
Caudal peduncle depth	11.9	8	10.6-12.0	11.4	9	9.8-11.3	10.8	12	11.6-13.4	12.4	6	11.3-12.1	11.7
Depth at dorsal-fin origin	27.0	8	25.7-31.3	28.2	9	26.6-29.6	28.4	12	26.4-29.6	27.9	6	26.7-29.1	28.1
Dorsal-fin height	26.1	7	25.0-28.5	26.4	7	23.1-25.7	24.5	12	23.7-27.8	25.9	6	24.5-26.7	26.0
Pelvic-fin length	18.6	8	16.7-18.6	17.7	9	15.4-17.5	16.7	12	17.1-20.0	18.5	6	15.8-18.2	17.4
Pectoral-fin length	20.8	8	20.3-21.7	20.8	7	18.6-21.4	20.0	10	18.6-21.6	20.4	6	20.0-22.5	20.9
Bony head length	25.2	8	25.0-27.6	26.1	9	24.7-27.8	26.1	12	23.5-25.3	24.6	6	23.0-25.3	24.3
Snout length	22.5	8	20.5-22.9	21.7	9	20.6-26.2	22.7	12	20.5-24.1	22.6	6	20.5-24.1	22.3
Upper jaw length	28.8	8	28.6-30.6	29.4	9	29.4-32.9	30.4	12	28.4-36.8	31.5	6	31.3-34.2	32.6
Horizontal eye diameter	33.8	8	31.3-34.3	32.6	9	30.0-35.3	32.7	12	32.1-36.8	33.4	6	33.3-35.6	34.7
Least interorbital width	31.3	8	28.6-31.3	29.7	9	26.8-30.8	29.3	12	28.0-32.1	30.0	6	29.5-31.6	30.4

15th principal caudal-fin rays curved, having dorsally concave profile; rays 13th and 14th thickened and bearing dorsally (on each side) 8 to 11 elongated and strong hooks in 1 row; Figs. 4–6. Young or immature males have 1 to 8 hooks on each of these rays; number of hooks increases according to size of specimen.

Scales cycloid. Lateral line usually not complete, with perforated scales 37 (31–37, $\bar{X} = 34.9$, $n = 4$; 31 in one specimen, other specimens 34–37), last one to three scales of this longitudinal row of scales not perforated. Total number of scales in lateral line row 37 (34–37, $\bar{X} = 36.5$, $n = 14$). Scale rows between dorsal-fin origin and lateral line 6 (5–6, $\bar{X} = 5.8$, $n = 18$), scale rows between lateral line and pelvic-fin origin 4 (3–4, $\bar{X} = 3.9$, $n = 18$). Predorsal scales 12 (11–13, $\bar{X} = 11.7$, $n = 18$), usually in 1 regular series. Scale rows around caudal peduncle 14. Males and females with a scale sheath on anal-fin base consisting of one row with 4 or 5 small scales covering bases of unbranched rays and first 4–5 branched rays.

Supraneurals 5 (4 or 5). Precaudal vertebrae, including Weberian apparatus, 17 (17–18, $\bar{X} = 17.1$, $n = 12$); caudal vertebrae, including posterior half centrum, 17 (17–19, $\bar{X} = 17.8$, $n = 12$); counts taken from x-ray negatives and one cleared and stained specimen.

Color in alcohol.—Both sexes with approximately same preserved color pattern; Figs. 1–2. Body pale brownish yellow in specimens preserved in formalin long enough to destroy guanine pigment. Lateral body stripe broad and black posteriorly, becoming pale and narrow anteriorly and disappearing anterior to dorsal-fin origin. Humeral spot absent. What appears to be a humeral spot in Figs. 1–2 is black interior wall of swim bladder seen through membranous tympanum plus a few extra dark chromatophores on borders of scales just anterior to tympanum. Dark body stripe continues broadly onto middle caudal-fin rays, but not extending to termination of these rays. Oth-

erwise caudal fin white or pale brownish yellow. Exposed borders of scales delineated by dark chromatophores, especially on dorsal body surface where the pigment is darker. Midline of dorsal body surface from nape to caudal-fin origin very dark. All fins hyaline except dorsal fin with 1 small dark bar between first and second rays from about distal tip of first unbranched ray and to about midpoint of second unbranched ray; Figs. 1–2. Head black to gray dorsally, especially dark near nape. Sides of head and opercles silvery where guanine pigment not destroyed by formalin, sides of head otherwise whitish yellow. Some dark chromatophores surround nares and border of upper jaw bones. Lower jaw white, without dark pigment except at symphysis where few dark chromatophores border its contours.

Sexual dimorphism.—The females lack hooks in the pelvic, anal, and caudal fins, while the mature, sexually active males bear numerous hooks on these fins. Caudal-fin rays thirteen and fourteen (rarely fifteen) of males bearing hooks and hypertrophied tissue. Large dorsal skin flaps occur along the connective tissue between the fourteenth and fifteenth caudal-fin rays and along thirteenth caudal-fin ray. Females have dorsal skin flaps along the proximal length of fourteenth and fifteenth caudal-fin rays, but these are small and almost imperceptible. The penultimate and antepenultimate ventral procurrent caudal-fin rays of males are ventrally expanded forming a small ventral keel on the caudal fin. These keels are absent in females.

Distribution.—Known from the basin of the rio São Francisco in Minas Gerais, Brazil. A second population found in the basin of the rio Jequitinhonha, Minas Gerais, Brazil is tentatively assigned to *A. melanogramma* (see Remarks below).

Etymology.—The name *melanogramma* is from the Greek, *melas*, = black + *gramme* = line. The name refers to the distinctive black bar on the large anterior unbranched dorsal-fin ray.

Remarks.—Besides the type specimens from the rio São Francisco basin, on which we based the above description, we obtained additional lots of what appear to be *A. melanogramma* from four localities along the rio Jequitinhonha. Although these specimens have the same counts and most other characters as those from the rio São Francisco, mature males of the population samples from these two river systems can be differentiated by their caudal peduncle depth relative to caudal peduncle length. Figure 8 illustrates these differences. Specimens available from the rio São Francisco basin seem to be fully mature, even though they are of smaller size than the fully mature specimens from the rio Jequitinhonha, but the sample sizes are small. We suggest that the differences we found in caudal peduncle length versus its depth might possibly be due to small sample size of fully mature adult males and prefer to not assign a new name for the rio Jequitinhonha population until further comparative material is available. However, it seems best to refer to the rio Jequitinhonha population sample as *Acinocheiroduon* cf. *melanogramma*. Other data from rio Jequitinhonha samples are: Anal-fin rays iii–v, 16–21, $\bar{X} = 18.4$, $n = 49$; mostly 17–19; 1 specimen 16, 2 specimens 20, and 1 specimen 21. Pectoral-fin rays i, 9–11, $\bar{X} = 10.4$, $n = 33$. Pelvic-fins i, 7–8, $\bar{X} = 7$, $n = 33$; i, 8 in one specimen. Dorsal procurrent caudal-fin rays 8–13, $\bar{X} = 10.4$, $n = 46$. Ventral procurrent caudal-fin rays 7–11, $\bar{X} = 9.6$, $n = 46$. Lateral line with 34–36 perforated scales, $\bar{X} = 35.5$, $n = 13$. Total number of scales in lateral line row 35–38, $\bar{X} = 36.8$, $n = 13$. Scale rows between dorsal-fin origin and lateral line 5–6, $\bar{X} = 5.8$, $n = 16$, scale rows between lateral line and pelvic-fin origin 3–4, $\bar{X} = 3.9$, $n = 16$. Predorsal scales 11–13, $\bar{X} = 11.8$, $n = 16$, usually in regular series. Scale rows around caudal peduncle 14. Supraneurals 4 or 5. Precaudal vertebrae, including Weberian apparatus, 16–18, $\bar{X} = 17$, $n = 66$; caudal vertebrae, including posterior half centrum, 16–19, $\bar{X} = 17.5$, $n = 66$;

counts taken from x-ray negatives and two cleared and stained specimens. For body and head ratios expressed as percentages; see Table 1. One male (MCP 19238, 31.9 mm SL) unusual in that 15th principal caudal-fin ray has two hooks dorsally.

Discussion of possible relationships.—The new species is placed in the Cheirodontinae on the basis of a new diagnosis of this characid subfamily provided by Malabarba (1994, 1998) and briefly discussed in Weitzman & Malabarba (1999). The new species shares all four synapomorphies proposed to diagnose cheirodontines: Presence of a large, nearly triangular hiatus of muscles covering the anterior swimbladder between the first and second pleural ribs (pseudotympanum), limited dorsally by the lateralis superficialis muscle, posteriorly by a naked anterior face of the second pleural rib, postero-ventrally by the obliquus inferioris muscle, and antero-ventrally by the obliquus superioris muscle; Humeral spot absent (Fig. 1–2); Teeth pedunculate, greatly expanded and compressed distally (Fig. 7); Only one tooth series present in the premaxilla (Fig. 7).

The new species also displays some, we suggest convergent, similarities with certain members of the characid subfamily Glandulocaudinae and the characid genus *Brittanichthys*. Burns et al. (1997) found that some cheirodontines are inseminating, as is the case for all examined glandulocaudines (Burns et al. 1995). We hypothesize, however, that the similarities of *A. melanogramma* to the species of *Brittanichthys* and glandulocaudines are homoplastic because *Brittanichthys* lacks the synapomorphies diagnosing the Cheirodontinae.

Mimagoniates microlepis (Steindachner, 1876) and *Mimagoniates rheocharis* Menezes & Weitzman (1990:389 fig. 5, and p. 401, fig. 24, p. 408 + pp. 419) also have hook-bearing, ventrally bowed caudal-fin rays. Menezes & Weitzman (1990) hypothesized a phylogeny of the glandulocaudine tribe Glandulocaudini that would exclude *A. melanogramma* from close relationship

Squares, rio Jequitinhonha, males
 $n = 20, Y = -0.0432 + 1.0048X; r^2 = 0.8780$
 Circles, rio Sao Francisco basin, males
 $n = 8, Y = 0.3974 + 0.7201X; r^2 = 0.7757$

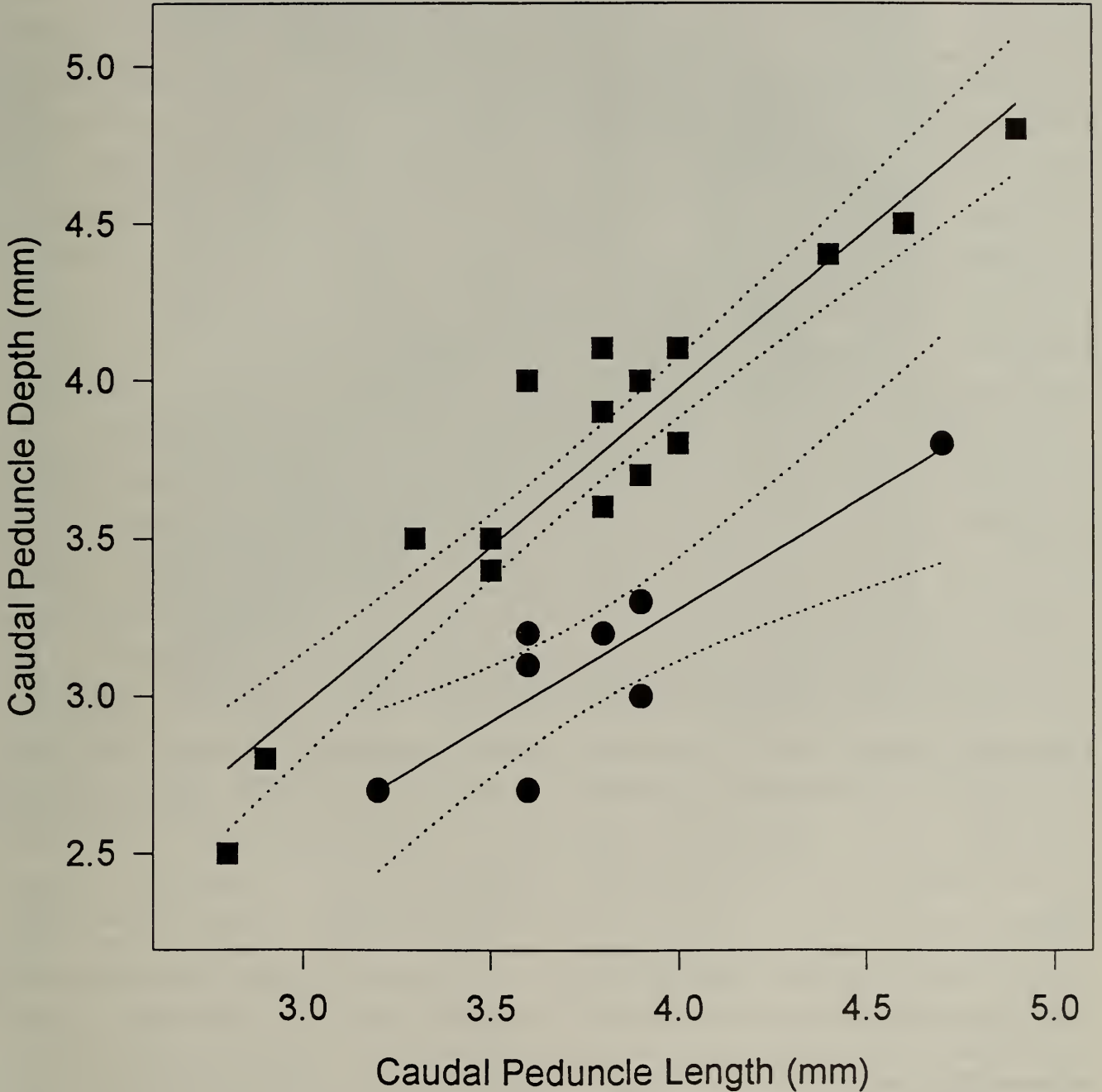


Fig. 8. Graph of caudal peduncle depth as a function of its length for *Acinocheiroduon melanogramma* from rio São Francisco basin (circles) and of *Acinocheiroduon cf. melanogramma* from the rio Jequitinhonha (squares). Note that the 95% confidence intervals do not overlap with the means of the compared population samples indicating a statistically significant difference. These differences are discussed in the text.

with the Glandulocaudini and especially with the derived glandulocaudin species, *M. microlepis* and *M. rheocharis*. *Acinocheiroduon melanogramma* lacks a hypertro-

phied caudal scale or scales associated with glandular tissue at the base of the tail that is apparently present in all glandulocaudines except *Landonia latidens* Eigenmann

& Henn in Eigenmann et al. (1914). *Acinocheiroidon melanogramma* also lacks the synapomorphies of the tribe Glandulocaudini and of the subfamily Glandulocaudinae (Weitzman & Menezes 1998). There are some soft structures associated with the base of the caudal fin in *A. melanogramma* that might be assumed to be an indication of glandulocaudine relationships. These are described as skin flaps and hypertrophied tissues between the thirteenth to fifteenth principal caudal-fin rays. *Acinocheiroidon melanogramma* apparently acquired its derived caudal tissues independently of those of the glandulocaudines because it lacks most of the features diagnosing the Glandulocaudinae and has those diagnosing the Cheirodontinae of Malabarba (1994, 1998).

Acinocheiroidon melanogramma, as well as certain other cheirodontines (see Burns et al. 1997), are inseminating characids as are glandulocaudines (Burns et al. 1995). We note, however, that glandulocaudines have a large area of the posterior testis modified for sperm storage, but this was not observed among examined inseminating cheirodontines, tribe Compsurini, including *Acinocheiroidon*, see Malabarba (1998). This further suggests, among other characters respectively diagnosing the glandulocaudine tribes and the Cheirodontinae, that insemination arose independently within the Cheirodontinae and in the Glandulocaudinae.

The male specimens of *A. melanogramma* have ventrally bowed caudal-fin rays bearing dorsoposteriorly recurved hooks in the ventral caudal-fin lobe as do males of *Brittanichthys axelrodi* Géry (1965b:fig. 9–10). The question of a relationship among *A. melanogramma* and the species of *Brittanichthys* is as problematic as the suggestion of a relationship of *A. melanogramma* to members of the Glandulocaudinae. Unfortunately the relationships of *Brittanichthys* with other characids remain uncertain. *Brittanichthys* was referred to a subtribe, the Aphyoditeini, of his tribe Cheirodontidi by Géry (1965a:14, 18, 20–22)

and to a tentative subgroup of the Cheirodontinae named the Aphyoditeina by Géry (1977:543) who spent a considerable effort in a precladistic attempt to discern the relationships of *Brittanichthys* based on certain of its anatomical resemblance's to other characid genera. Géry justifiably had many reservations about his results, but suggested that *Brittanichthys* might be related to *Leptobrycon* Eigenmann (1915) and *Thrissobrycon* Böhlke (1953). We do not argue with that opinion and suggest that the preliminary osteological evidence we have seen may confirm this, but, as Géry, we believe that the matter needs much further investigation. Géry (1977:591, 594) essentially did not alter his estimate of the relationships of *Brittanichthys*. Géry's Aphyoditeina has never been phylogenetically diagnosed but its included genera (*Paracheiroidon* Géry (1960a), *Atopomesus* Myers (1927), *Oligobrycon* Eigenmann (1915), *Aphyocharacidium* Géry (1960b), *Oxybrycon* Géry (1964), *Axelrodia* Géry (1965a), *Prodontocharax* Eigenmann & Pearson in Pearson (1924), *Microschemobrycon* Eigenmann (1915), *Parecbasis* Eigenmann (1914), *Macropsobrycon* Eigenmann (1915), *Aphyodite* Eigenmann (1912), *Brittanichthys*, *Leptobrycon* and *Thrissobrycon*) were placed in the Cheirodontinae by Géry (1977:586–587, 590–591, 594–595) apparently because its species have a single row of premaxillary teeth. We note here that *Paracheiroidon simulans* Géry (1963) is an exception and has two rows of premaxillary teeth; see Weitzman & Fink (1983). We cannot treat the putative Aphyoditeini or Aphyoditeina here except to note that only two of the genera (*Macropsobrycon* and *Prodontocharax*) placed in this subtribe by Géry were considered Cheirodontinae in the more restrictive sense of Malabarba (1994). See Malabarba (1998) for further comments on the Aphyoditeini and the Aphyoditeina and a historical review of the various treatments by Géry of the genera he ultimately included in his Cheirodontinae, Géry (1977).

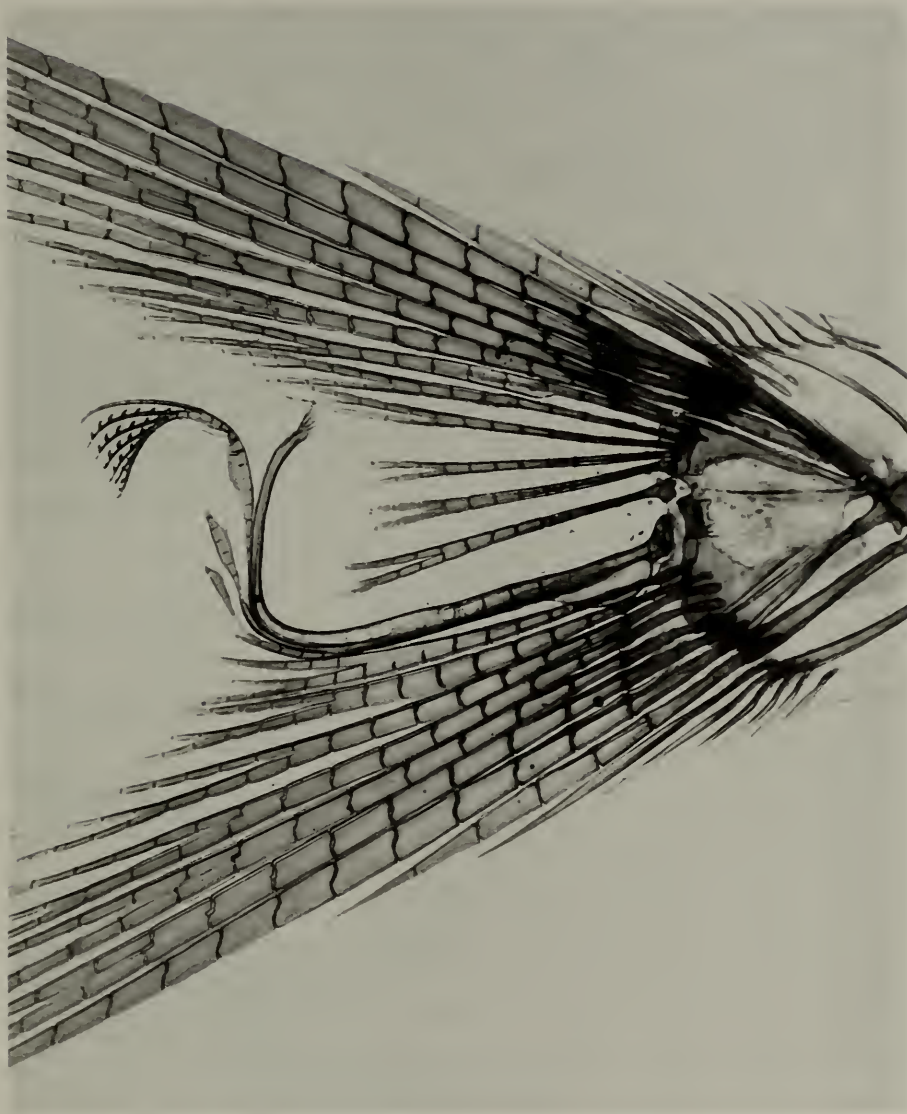


Fig. 9. *Brittanichthys axelrodi*, USNM 221992, cleared and stained male, 22.7 mm SL; Brazil, Amazonas, rio Negro, near mouth of rio Urubaxi. Caudal-fin base, procurrent caudal-fin rays and hook-bearing portion of caudal fin. Anterior to right.

Géry (1965:14) also considered the possibility that *Brittanichthys* might be a glandulo-caudine. His opinion was that if it does belong among that group (which he suggested is polyphyletic) its relationships could be remotely with the Xenurobryconini. Weitzman & Fink (1985:13, 21) noted that although *Brittanichthys* shared fused hypurals and parhypural with the xenurobryconin glandulo-caudines, its lack of both a caudal gland and the modified xenurobryconin arrangement of the caudal squamation excluded any relationship based on a cladistic analysis of the character distributions of the taxa they studied. According to Weitzman et al. (1994:53), however, the

fact that *Brittanichthys* is an inseminating characin with a sperm storage area in the testis raises the question again. See also Weitzman & Menezes (1998).

Although *A. melanogramma* and *Brittanichthys axelrodi* share recurved hooks on the caudal fin and share curved ventral caudal-fin rays, these structures are derived in different ways in these two genera (compare Figs. 3–6 and 9–10). *Acinocheiroduon melanogramma* has several soft caudal structures that are derived states apparently absent in *Brittanichthys*. The derived curved fin ray of *Brittanichthys* is the twelfth principal caudal-fin ray (Fig. 9–10) while in *A. melanogramma* it is the thir-



Fig. 10. *Brittanichthys axelrodi*, USNM 221992, cleared and stained male, 22.7 mm SL; same locality data as in Fig. 9. Hook-bearing portion of caudal fin, right side, anterior to right.

teeth through the fifteenth principal caudal-fin rays (Figs. 4–6). As noted in Weitzman & Fink (1985:13, 21) and Weitzman et al. (1994) the parhypural and hypural are fused in *Brittanichthys*. In our cleared and stained specimens of *Acinocheirodon* these bones are separate (one C&S specimen of *A. melanogramma* has them so closely placed that we can only distinguish the two isolated elements by pressing them with a needle where they are in contact). This removes a source of possible synapomorphic support for a relationship between these

taxa. The fact that *A. melanogramma* has the cheirodontine synapomorphies and that these are absent in *Brittanichthys* corroborates a hypothesis that *A. melanogramma* is not closely related to *Brittanichthys axelrodi*.

Among cheirodontine genera, in the more restricted sense of Malabarba (1994), *A. melanogramma* (called “undescribed genus and species B”—MCP 18596, MCP 18597 and MCP 18598—by Burns et al. 1997 and “new genus and species B” by Malabarba, 1998), *Saccoderma melanostig-*

ma Schultz (1944), *Compsura heterura* Eigenmann, *Compsura gorgonae* (Evermann & Goldsborough, 1909), *Macropsobrycon uruguayanae*, some species currently referred to the polyphyletic “*Odontostilbe*,” “*O.*” *dialeptura* (Fink & Weitzman, 1974) and “*O.*” *mitoptera*, and an undescribed species (called “undescribed genus and species A” by Burns et al., 1997 and “new genus and species A” by Malabarba, 1998) were found to be inseminating. Also, all these species have hypertrophied caudal tissues and/or hooks on the caudal-fin rays, suggesting they may represent a monophyletic group and were united in the cheirodontine subtribe Compsurini by Malabarba et al. in Malabarba (1998).

Homologies of the specialized structures and putative apomorphies in the caudal fin among inseminating cheirodontines, need further investigation. Each of the three genera listed above have apomorphies that allow their recognition as natural assemblages among the Cheirodontinae, but possible hypotheses of possible relationships among them and with *A. melanogramma* need phylogenetic study.

Acinocheirodon melanogramma has hooks in the ventral lobe caudal-fin rays as do certain other inseminating cheirodontines. *Acinocheirodon melanogramma* has large recurved hooks along the dorsolateral surface of the dorsal branches of caudal-fin rays 13–14, and rarely and less-developed hooks also on ray 15. Caudal-fin hooks are also present in *Saccoderma hastata* (Eigenmann, 1913) and are distributed on the thirteenth to eighteenth (usually the fourteenth to the seventeenth) principal caudal-fin rays. In “*Odontostilbe*” *dialeptura* caudal-fin hooks occur on the twelfth to sixteenth, and in *Macropsobrycon uruguayanae* from the twelfth to fourteenth caudal-fin rays (plus several spinelets along the proximal half of the caudal-fin rays 14 to 18). See Fink & Weitzman (1974:8, fig. 3 and 34, fig. 26) respectively for figures of the caudal fins of “*O.*” *dialeptura* and *S. hastata*. These two species have one hook for each

ray segment except at the distal end of each ray where the hooks are small and there may be as many as three hooks per segment, especially in *S. hastata*. *Macropsobrycon uruguayanae* has one hook for each ray segment along the distal one-third of caudal-fin rays twelve to fourteen. The hooks on the caudal-fin rays of all these species are on the dorsolateral surfaces of the rays. In *Saccoderma hastata* and *O. dialeptura* the hooks occur on at least two of the branches of the larger rays (13–15). The hooks are not large and organized like those of *A. melanogramma* on thickened rays. Instead the rays of all examined cheirodontine species except *A. melanogramma* remain slender in their hook-bearing areas. Further, the hooks of the other inseminating cheirodontines are relatively small compared to the hooks on the anal fin of *A. melanogramma* whose caudal-fin hooks are considerably enlarged. Although the hooks are present on the ventral lobe of the caudal fin in all the species discussed, they do not all occur on the same caudal-fin rays and are of different shapes. Caudal-fin ray hooks may be informative regarding relationships among inseminating cheirodontines and deserve further investigation, but the presence of hooks in the lower lobe of the caudal fin itself as a synapomorphy uniting *A. melanogramma* to those other inseminating cheirodontines bearing hooks is not congruent with a cladogram (Malabarba 1998) of inseminating cheirodontines that results from other characters discussed below.

Species of *Saccoderma*, have an enlarged caudal-pouch scale in the ventral lobe of the caudal fin, mainly represented by the posterior ultimate scale of the scale row immediately ventral to the lateral-line scale row. This scale has a free posterior border and covers a pouch open to the surrounding water. While bearing hooks on the lower lobe of the caudal fin, neither *A. melanogramma* nor *Macropsobrycon uruguayanae* have modified caudal-fin scales, as described for *Saccoderma*. A pouch scale, not as well-developed as in species of *Saccod-*

erma, is also found in the lower caudal-fin lobe of *Compsura heterura*. This species bears no caudal-fin hooks, but is inseminating. *Compsura gorgonae* is like *Compsura heterura*, but has a less modified caudal scale. *Compsura heterura*, *Compsura gorgonae*, and *Saccoderma* species have the enlarged scale connected dorsally to ligaments arising from the twelfth and thirteenth principal caudal-fin rays, and ventrally to a skin flap connected to the nineteenth principal caudal-fin ray. This suggests that the derived caudal fin, its scales, and its ligaments are homologous among these cheirodontines. *Odontostilbe dialeptura* also has some enlarged scales on the ventral caudal-fin lobe, but these are not as developed as those found in the species of *Compsura* and *Saccoderma* and are attached to the fourteenth and nineteenth principal caudal-fin rays.

Males of *A. melanogramma* have a large dermal flap or fold that extends posteriorly from between the interradians muscles. This flap originates between the fourteenth and fifteenth principal caudal-fin rays and mostly overlaps the fourteenth ray along almost its entire length (Fig. 6). This flap forms the ventrolateral wall of a shallow, elongate dorsally open pocket or trough that lies between the flap and the body of the fourteenth ray. There is a smaller ventral flap, along the posterior half of this structure that does not overlap the fifteenth principal caudal-fin ray ventrally. The fourteenth principal caudal-fin ray also has a dorsally directed skin flap along the proximal two-thirds of its length. This flap does not overlap the thirteenth principal caudal-fin ray. On the dorsal caudal-fin lobe there are two additional flaps. These are folded or directed ventrally. These flaps extend about half the proximal length of the sixth and seventh rays. Females also have dermal flaps extending ventrally from the sixth and seventh caudal-fin rays and dorsally from the fourteenth and fifteenth rays, but these are always smaller than that flaps described for the males. These flaps do not show in

Fig. 2, being obscured by other caudal-fin tissues. These flaps are very similar in appearance to lateral ray skin flaps sometimes found on the dorsal, anal and also caudal-fin rays of fishes that live in fast water streams and fold their fins to reduce friction of the fin while swimming. Many characids, as for example *Brycon pesu* Müller and Troschel, have such flaps, although they are smaller in relative size than those of *A. melanogramma*. The large, derived flaps present in males of *Acinocheirodon* constitute one of the apomorphies of the genus (see the Diagnosis of *Acinocheirodon*). None of the other inseminating cheirodontines has derived skin flaps as described for *A. melanogramma*. Species of *Saccoderma* and *Compsura heterura* also have small, slightly circular skin flaps along the midlength of the dorsal border of the principal caudal-fin rays 16–19 and 15–19, respectively. These flaps occur near the opening of the caudal pouch medial to the enlarged pouch scale. These flaps are found on different caudal-fin rays than in *Acinocheirodon*, and have distinctly different shapes. They are putatively considered non homologous with the similar structures in *Acinocheirodon* because they occur on different rays.

In addition, *A. melanogramma* has hypertrophied soft tissue, especially around the hooks of the thirteenth and fourteenth fin rays (Fig. 3). This hypertrophied tissue extends anteriorly in continuously reduced amounts along these fin rays to their proximal ends and also occurs distributed along the fifteenth principal caudal-fin ray that has no hooks.

Weitzman & Fink (1985:96–99) rather extensively discussed caudal-fin structures and their possible function among glandulo-caudines, and proposed that many of the modified structures of the male xenurobryconin caudal fin and the pouch scales of other glandulo-caudines may serve as a pumping mechanism increasing the rate of dissemination of a pheromone or pheromones into the surrounding water from glandular tissue situated in and around the

opening of the pouch or sac. Almost all glandulocaudines have a caudal pumping mechanism, but most have a "passive pump" in that there is no derived direct caudal muscle involvement. In the Xenurobryconini there is direct, derived muscle involvement, especially in *Xenurobrycon* Myers & Miranda-Ribeiro (1945), *Tytocharax* Fowler (1913), and *Scopaeocharax* Weitzman & Fink (1985). Although considered non homologous structures with regard to those in glandulocaudines, the relatively large scale structure and flaps of the inseminating cheirodontines could have a similar function to that in the species of the glandulocaudines. This could be true for the various species of *Saccoderma* and for *C. heterura*, which have developed skin flaps near the opening of the caudal pouch scales. However, *A. melanogramma* does not have any pumping mechanism involving caudal-fin scales. Instead, it has two large skin flaps between the thirteenth and fifteenth principal caudal-fin rays, just ventral to and surrounding the hypertrophied soft tissue found around the hooks of the thirteenth and fourteenth fin rays. This tissue may be glandular in nature, but we have no histological preparations of it at this time. The courtship behavior of this species has not been observed, but we suggest that the large and specialized skin flaps of the caudal fin in *A. melanogramma* males may also be part of a mechanism for increasing the rate of pheromone dissemination in the surrounding water during courtship. Mechanisms for the dissemination of pheromones may be important for inseminating characids, both cheirodontines and glandulocaudines.

Caudal fin structures aside, tooth morphology suggests that *A. melanogramma* could be related to the genera *Aphyocheirodon* Eigenmann (1915) and *Cheirodontops* Schultz (1944). The teeth of *Acinocheirodon* usually have five cusps and are differentiated according to their distribution on the jaws (Fig. 7). The five-cuspid premaxillary teeth are symmetrical and elongate

with the central cusp the largest. The anteromedial dentary teeth are the largest in the lower jaw and are usually five-cuspid. Each of the dentary teeth has the central three cusps largest and of equal size. The lateral cusps of each tooth are tiny and are situated more ventrally than the three medial cusps. The remaining more laterally-placed dentary teeth, are posteriorly graded and reduced in size, robustness, and cusp number with the most posterior tooth often unicuspid. These teeth are similar to those found in *Aphyocheirodon hemigrammus* Eigenmann (1915) and *Cheirodontops geayi* Schultz (1944), but similar teeth are also found in *Serrapinnus microdon* (Eigenmann, 1915), *Serrapinnus heterodon* (Eigenmann, 1915), and *Holoshesthes pequirá* (Steindachner, 1882).

Serrapinnus microdon and *Serrapinnus heterodon* share several synapomorphies with *Cheirodon* and *Spintherobolus* as briefly discussed by Malabarba (1998). Species in these genera are not inseminating and thus are not considered as closely related to *Acinocheirodon melanogramma* or the other inseminating cheirodontines. See Malabarba (1998) for a more complete discussion. *Holoshesthes pequirá* appears more closely related to *Odontostilbe fugitiva* Cope than to any other described Cheirodontinae (as hypothesized by Malabarba, 1994, 1998), and is also not inseminating (Burns et al. 1997).

Although tooth morphology suggests *Acinocheirodon* may be related to the genera *Aphyocheirodon* and *Cheirodontops*, insemination is unknown for both later genera. However, no mature specimens of these last two species were available for examination. We are not confident about a hypothesis of close relationship between *Acinocheirodon* and the genera *Aphyocheirodon* and *Cheirodontops* because tooth morphology is highly variable among other characids and also among cheirodontines. The specialized dentary teeth, with the three central cusps about equally developed and forming the cutting edge may have evolved

several times in the Cheirodontinae, for example in *H. pequirá*, *S. microdon* plus *S. heterodon*, *Acinocheirodon*, *Aphyocheirodon* and *Cheirodontops*, as supported by Malabarba's (1998) hypothesis of relationships among cheirodontines. Histological studies of gonads and morphological studies of the caudal fin of adult and mature specimens of both genera may provide new and better insights about the relationships of these cheirodontine genera.

Comparative material.—*Brittanichthys axelrodi*: USNM 221992, 1 C&S spm, male, 22.7 mm SL, Brazil, Amazonas, rio Negro, near mouth of rio Urubaxi, Amazonas, Brazil. *Compsura gorgonae*: MCP 11988, 3 C&S spms, MCP 11989, 7 spms, rio Caimito at Chorrera falls, in backwater above dam, Panama Prov., Panama. *Compsura heterura*: MZUSP 39177, 9 spms, ribeirão do Gado, tributary of rio São Francisco, Minas Gerais, Brazil. *Macropsobrycon uruguayanae*: MCP 11996, 2 C&S spms, arroio Dom Marcos, on the road BR 290, Rio Grande do Sul, Brazil and MCP 16169, 13 spms, Antioquia, Uraba, tributary of rio Guap, rio Leon drainage, Colombia. *Odontostilbe dialeptura*: MCP 11992, 5 C&S spms and MCP 11989, 15 spms, creek about 4 mi up Pese Road from junction with Chitre–Divisa Road, Herrera Province, Panamá. *Odontostilbe mitoptera*: MCP 14713, 2 C&S spms, rio Claro-Golfito road, just east of Bar Roded, Costa Rica. *Saccoderma hastata*: FMNH 56383 (holotype), Soplaviento, Colombia. *Saccoderma melanostigma*: USNM 228325, 7 specimens, Zulia, rio Yasa MCPO. Libertad, Estado Zulia, Venezuela. *Saccoderma robusta*: USNM 175308, 16 spms, Chibogado, Sinu Cordoba, Colombia.

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